Space Weather Technical Forecast

Issued on Saturday, 03 December 2022 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active high energy electron fluence. Daily chance of M-flares. Slight chance G1 Minor Storms, mainly early day 2 (4th) with any CME arrival or late day 4 (6th) with HSS arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with a peak flare of C8.1 at 02/0920 UTC, observed from the plage area to the south of new sunspot AR3156 Hsx/alpha on the northeast limb. A small flare was also observed at the same time in AR3153 Fho/Beta, a large but mature, stable and open structured group in the southeast disc. There are three other regions on the Earth-facing disc, however these are all much smaller and simpler. No Earth-directed CMEs occurred in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind was indicative of the fast solar winds from a coronal hole. Wind speeds have been Elevated to Strong, with ACE showing wind speeds peaking at around 800 km/s, before gradually declining to below 700km/s. DSCOVR has observed slower speeds of around 500-600km/s however this disparity was likely due to density being generally below average. Total IMF Bt was generally weak between 2 and 5nT. The north-south component Bz was variable between -4nT and +4nT. Phi angle was positive throughout (Away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES-16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES-16 has been High throughout, peaking at 8780 pfu at 02/1915 UTC. The associated 24 hour Fluence was above the Active (1e8 integrated pfu) threshold throughout. Observed fluence at 03/0000 UTC was 3.94e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, but with a daily chance of rising to Moderate with an ongoing potential for M-flares, primarily from AR3153 in the southeast.

Solar Wind / Geomagnetic Activity: A slow CME from 29th Nov may arrive at Earth early on 4th +/- 9 hrs. Ongoing fast wind environment is expected to only gradually fade through the period easing to slightly elevated by the end of day 1 (3rd). The fast wind from CH53/- may arrive at Earth from late day 4 (6th), with solar wind speeds reaching in the region of 500-600 km/s. Quiet to Unsettled with chance of Active intervals are expected through the period. Any CME arrival will bring the chance of a further spell of Active to G1/Minor Storm intervals from late day 1 (3rd) or more likely day 2 (4th), with the risk passing by day 3 (5th). Day 4 (6th) may see an early arrival of CH53/-, with only a slight chance of G1/Minor storming due to being a negative feature.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES-16, is expected to remain at Background throughout. High energy electron flux (greater than 2 MeV), as observed by GOES-16, is expected to remain predominantly High with Fluence levels persisting above the Active (1e8 integrated pfu) fluence threshold.

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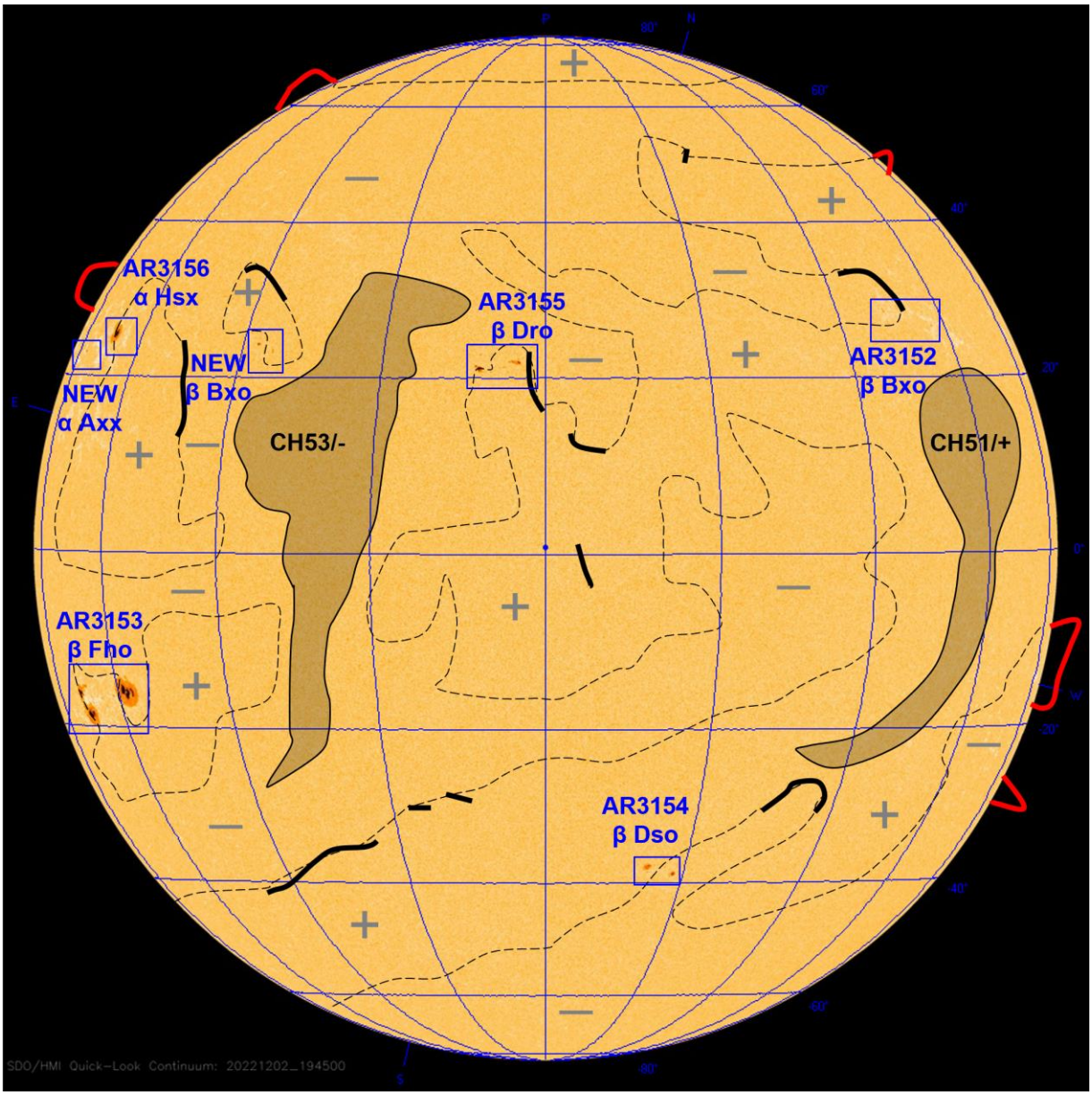
Figure 1. Solar Analysis Valid 02/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption on 29 Nov, and its associated CMEs have been assessed as slow, but with the possibility of Earth-directed components, although this is low confidence. Any arrival is most likely to occur early day 2 (4th), perhaps very late day 1 (3rd). The CME from the M1 flare of AR3152 at 01/0721 UTC is expected to miss, passing to the north and ahead of Earth.

Ongoing fast wind environment is expected to only gradually fade through the period as indicated by MOSWOC enlil. The 27-day persistence also indicates a gradual decline, albeit slightly faster, with solar winds around 400 km/s by late day 1 (3rd). However, CH51 is a larger feature on this rotation supporting to the forecast from the Enlil model.

Toward the end of the period, the fast wind from CH53/- may arrive at earth. It's current location is to the east of the meridian, therefore giving an arrival of late day 4 (6th) or perhaps after, with solar wind speeds reaching in the region of 500-600 km/s. This is yet another feature that appears darker and larger than on the previous rotation, therefore giving faster speeds than previously seen. However, due to this coronal hole being a negative feature, it is less likely to have a geomagnetic impact at Earth.

Quiet to Unsettled with chance of Active intervals are expected through the period. Any CME arrival will bring the chance of a further spell of Active to G1/Minor Storm intervals from late day 1 (3rd) or more likely day 2 (4th), with the risk passing by day 3 (5th). Day 4 (6th) may see an early arrival of CH53/-, with a slight chance of G1/Minor storming.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	20	5	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
25/1904	Partial	Filament	Central S Hemisphere	630 km/s	04/0600UTC	Low Confidence

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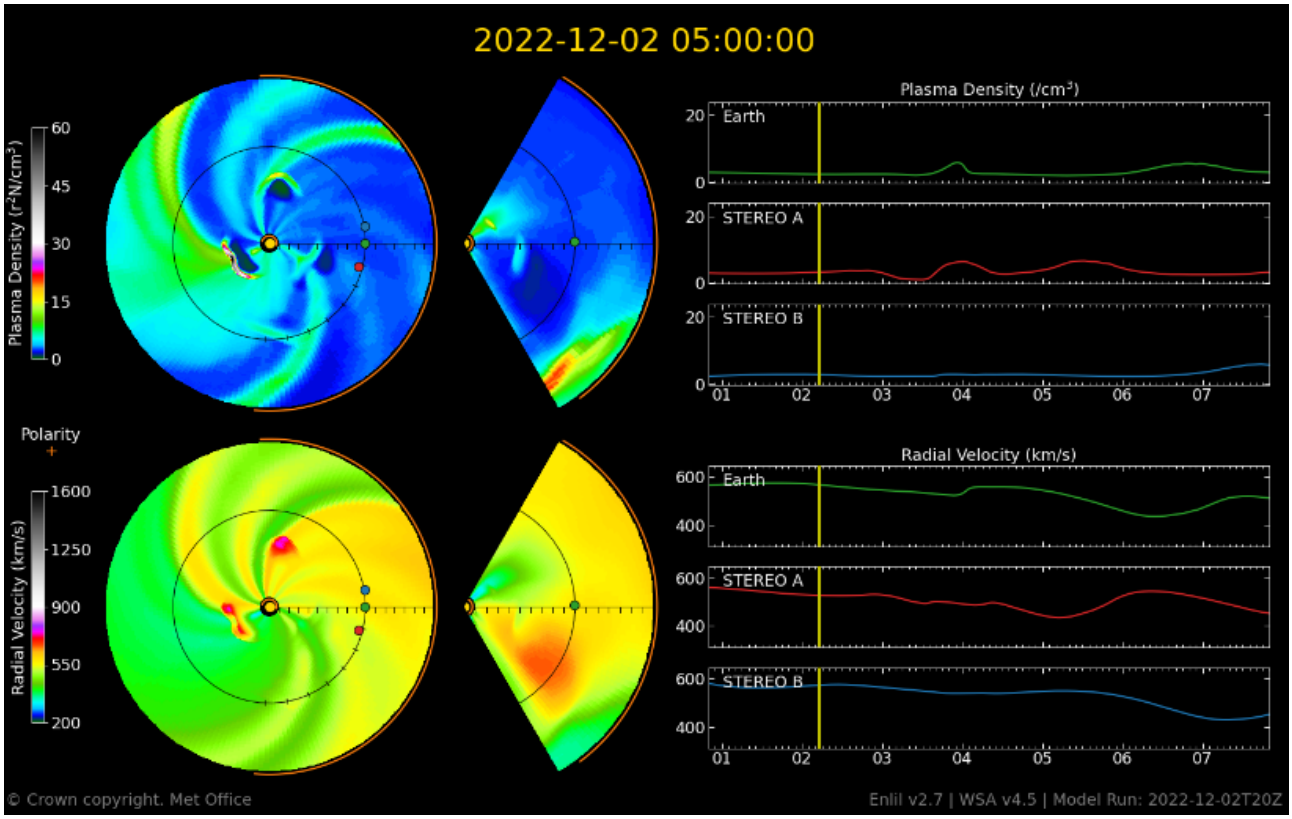
Figure 2: MOSWOC ENLIL



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Radio Blackouts - X-Ray Flares:

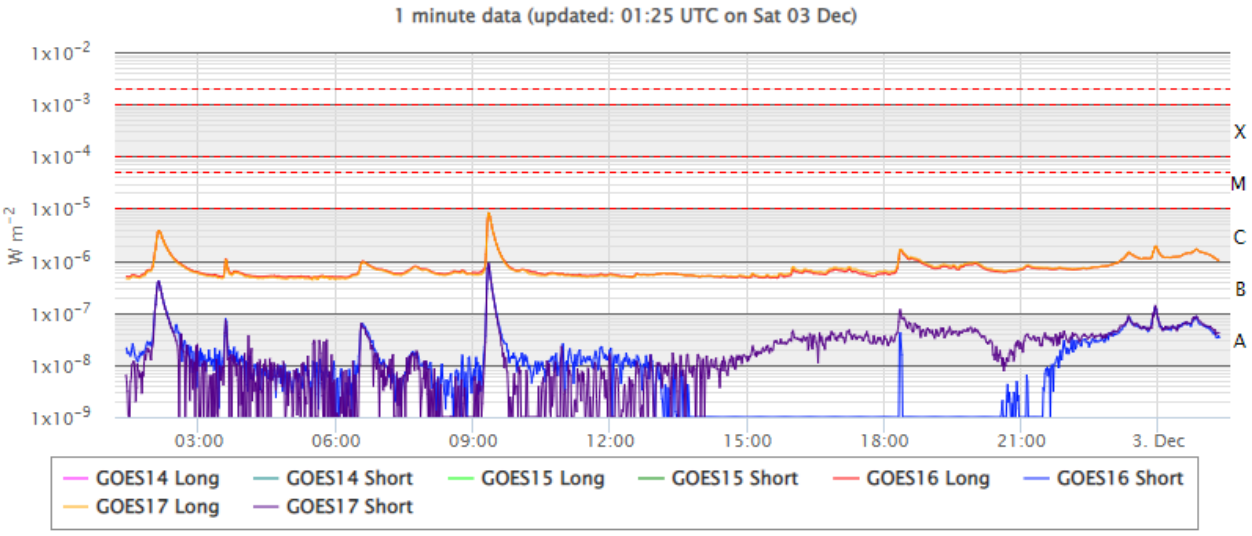
Solar activity is forecast to be Low, with further C-flares expected, and a daily chance of rising to Moderate with isolated M-flares possible.

This is primarily due to AR3153 Fho/Beta in the southeast. This has been moving towards a clearer viewing angle, with confidence increasing for a relatively simple, albeit large spot with a mature and currently stable bipolar east-to-west aligned field. Despite this, the spot does contain a large amount of potential energy giving the potential for notable flaring should any destabilisation occur.

There are six other sunspot regions, however these are all generally smaller and less likely to give significant flares. The two central disc regions AR3154 Dso/Beta in the south and AR3155 Dro/Beta in the north have only exhibited slow development, whilst AR3152 Bxo/Beta in the northwest remains simple after its M1.0 flare on the 1st Dec. AR3156 Hsx/alpha near the northeast limb appears to be a mature spot, set amongst a bright area of plage and a single NEW Axx/Alpha, although there is the potential for more spots to rotate onto the disc given the bright signal for this area on STEREO A euvi. Another NEW and simple region has developed in the northeast quadrant, currently analysed as a Bxo/Beta.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: 24 hour X-Ray trace



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16, is currently at background levels and is expected to remain at this level throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV), as observed by GOES16, is currently at High levels (above 1000 pfu) and expected to persist at this level for much of the period, with a potential increasing trend. There is a chance of a drop out early day 2 (4th) due to any potential CME arrival.

Consequently the associated Fluence levels are currently above the Active (1e8 integrated pfu) and are expected to increase through the following days as the HSS wanes. Confidence is high that the fluence will remain predominantly above Active with only a slight reduction in confidence later in the period. REFM has struggled to handle the recent fast wind arrivals, however it is now giving good guidance for Active fluence to persist.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	80	80
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	10	10	10	5

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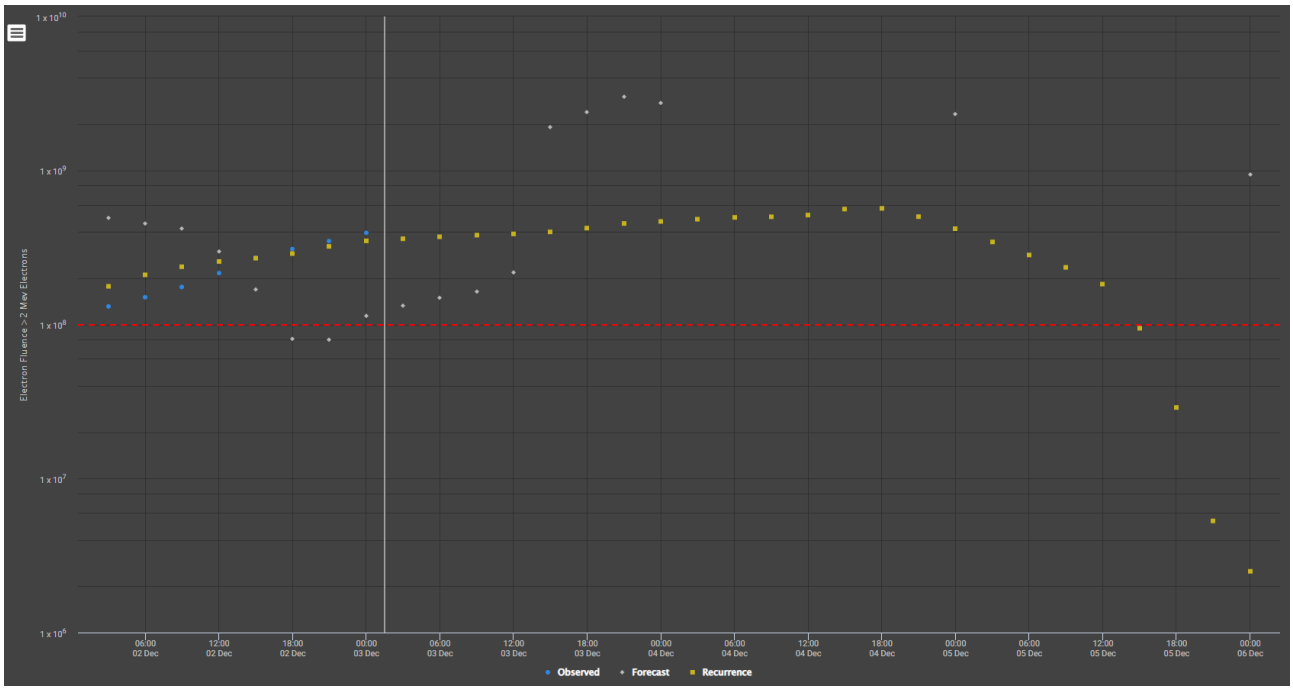
Figure 5: REFM integrated flux and fluence.



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